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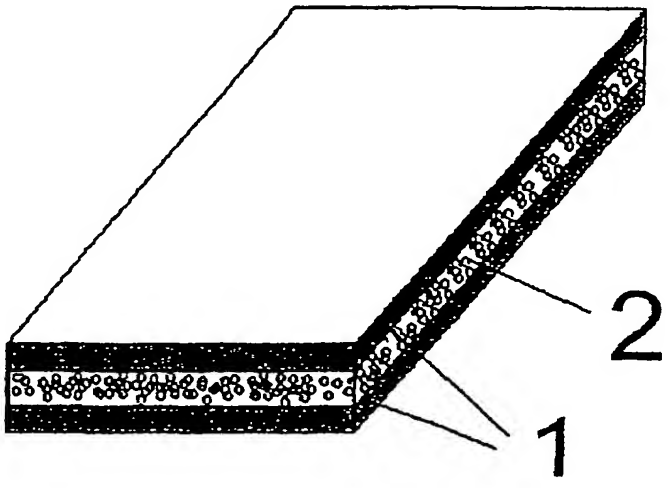
(54) Title: BOARD HAVING A FOAMED CORE AND A HIGH CONTENT OF CELLULOSE-BASED FILLER



(57) Abstract: The invention relates to a board having a synthetic compound of a thermoplastic polymer and cellulose-based filLer. The board has a foam core (2) and a substantially solid skin (1) on both sides. The filler preferably is at least 45 % by weight of the board and is substantially cellulose-based, preferably sawdust, wood floor, agro-fibre or paper. Because of the high content of said filler, the board combines the favourable properties of the thermoplastic polymer and the filler. When using substantially saw dust or wood flour an excellent wood substitute is obtained.

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Board having a foamed core and a high content of cellulose-based filler.

The invention relates to a board provided with a foam core having a substantially solid skin on both sides, in which the foam core and the skin are made of the same synthetic compound which comprises a thermoplastic polymer and cellulose-based filler.

In British patent 1.052.289 such foamed polymer products are described of thermoplastic polymers and 5-75% by weight of fibre material having a fibre length of 0.05-1.25cm. The fibre material can be chosen from amongst others asbestos, wood and nylon.

Such products are generally unsuitable as wood substitutes. Said fillers such as for instance talcum, chalk, glass fibre and asbestos make the product difficult to process, for instance by gluing or painting. Additionally, amongst others the watertightness and the specific gravity is not optimal as a result of the particle size. Moreover a board described in the patent is not suitable for use in construction because of the limited mechanic properties.

The invention now intends to provide a board which at least partially overcomes said disadvantages. The invention consists in the board being provided with a foam core having a substantially solid skin on both sides, in which the foam core and the skin are made of the same synthetic compound which comprises a thermoplastic polymer and cellulose-based filler, the cellulose-based filler being in powder form.

The invention also consists of a process for the manufacturing of a board according to the invention using low pressure injection moulding in a gas-proof mould at a mould pressure of 60 bar at a maximum and in which a gas counter pressure prevails, sufficient to prevent premature expansion of the injection mixture which comprises thermoplastic polymer, cellulose-based filler and blowing agent or water or inert gas, in which after the mould has been partially or entirely filled the injection mixture is allowed to expand, the mould providing counter pressure.

By using a low injection pressure an almost tensionless board is obtained, which is not sensitive to twist in further processing steps. Moreover the process has a larger process window, as a result of which the range of requirements regarding the used raw materials in the processing processes is larger.

By using a cellulose-based powdered filler, it is possible to combine the positive properties of the used filler with the positive properties of thermoplastic polymers, namely, simple processing, easy mouldability and good resistance against the action of moisture. When for instance wood flour or sawdust or agro-fibre are used as filler the board can very well be used as a substitute for a wooden board, especially as construction material for exterior uses. The board according to the invention has such properties that it complies with NEN-standard 3278 interior 1, exterior 1 and exterior 2. Moreover, as a result of the user filler the board can be worked on very well with conventional wood processing equipment and can be glued, lacquered and/or painted well. To that end the board has to be sanded lightly. The filler here ensures optimal mechanic properties. Additionally exact sizes are possible as a result of the manner of manufacturing and the material used.

The board according to the invention comprises a thermoplastic polymer. In

the application a polymer is meant which can be processed in an injection moulding process. The processing temperature of such a polymer then has to be such that its filler is not adversely affected by it. The polymer therefore has to processable at a temperature up to approximately 200 degrees Celsius.

Suitable .polymers according to the invention are polypropylene, polyethylene, polyvinyl chloride, polystyrene, styrene-butadienes, styrene-acrylonitrile, acrylonitrile butadiene styrene, acrylonitrile styrene acrylate, polyamide, polyoxymethylene, polycarbonate, polyethylene terephthalate, polybutylene terephthalate, polyphenylene oxide and thermoplastic polyutherane. Of said thermoplastic polymers preferably polystyrene, polypropylene or polyethylene are used. Said polymers result in a product with little to no swelling when exposed to moisture. As a result the product is able to comply with the above-mentioned standards.

Preferably however, re-used plastic is used in the form of industrial production waste. Said material could possibly be used in combination with new material of the above-mentioned polymers. Additionally also biologically degradable polymers are preferred such as starch-based polymers and poly lactic acid. Examples of such polymers are amongst others described in US 5827905.

According to the invention the board apart from thermoplastic polymer consists of at least 45% by weight of cellulose-based filler. Preferably the content of said filler is at least 50% by weight and more preferably at least 60% by weight. Optimal results are obtained with a content of cellulose-based filler of at least 80% by weight. A higher content has a positive effect on the cost price of the board. In practice the board will comprise a maximum of 95% by weight of said filler.

When using a powdered cellulose-based filler a very good wood substitute was obtained at a content of cellulose-based filler of 45-65% by weight, preferably 45-60% by weight. An optimal result as wood substitute was obtained at a content of cellulose-based filler of approximately 50% by weight. In order to obtain an optimal wood substitute a combination of cellulose-based filler with poly olefin, preferably polyethylene or polypropylene, turned out to give good results at 40-60% by weight of poly olefin. In case of more cellulose-based filler the moisture resistance turned out to deteriorate, and the board became too heavy. With a higher content of poly olefin the procesability turned out to deteriorate: the product could be glued and painted less well. Polymers such as polyethylene in solid have a large linear expansion coefficient: approximately $1{,}8.10^{-4}K^{-1}$. In the uses according to the invention the product has a low linear expansion coefficient when polyethylene is used. Additionally particularly polyethylene and polypropylene do not give harmful waste products.

The cellulose-based filler suitable according to the invention will preferably consist of sawdust, possibly pulverized, wood flour, wood pulp, agro-fibres from flax, hemp or jute, or pulp thereof, paper or paper pulp. Said material is preferably used having a particle size of approximately 20 mesh, in order to prevent too large particles being present. Preferably the particle size is approximately 35-60 mesh (a particle size of 0-0.5 mm to -.25mm). Such a particle size is cellulose powder. Preferably said material is used in the form of residue material or material made suitable for re-use.

Apart from said components such as thermoplastic polymer and cellulose-based filler the board may comprise additives such as stabilisers, colorants compatibility improvers or fire retardants. Additionally if so desired, small quantities of other fillers can be used. The use of such additives and the suitable kinds are known to the expert however.

The board according to the invention can be manufactured in various ways. Preferably, however, the board is manufactured by means of low pressure injection. Said technology is based on the injection moulding process, in which the viscosity of the material to be treated is lowered by adding blowing agents, water or inert gas such as nitrogen. As a result it is possible to make the board from thermoplastic polymer having a high content of cellulose-based filler. The board can be manufactured without tension because of the low pressure. As a result the board will not twist during further processing. An additional advantage is that fluctuations in the supplied raw material, such as for instance the water contents of the filler, will be easy to compensate in the production process.

The synthetic compound is injected into a preferably gas proof mould under the already mentioned relative low pressure of 60 bar (mould pressure) at the most. When using a gas proof mould a relatively smooth surface will be obtained and jetting is prevented. Preferably a gas counter pressure system is used. In a gas proof mould a counter pressure is created which is larger than the vapour pressure of the blowing agent. As a result premature expansion of the melt is then prevented. When the mould cavity is entirely filled, the counter pressure is relieved and volume expansion can take place. Optimal results are achieved when the melt is brought directly from the extruder to the plunger, and directly injected from the plunger into the mould.

By means of said production technique it is possible to manufacture a board having a foam core. The foam core is created by adding blowing agent, water or inert gas such as for instance nitrogen. To that end the thermoplastic polymer with the filler and possible other additives together with the blowing agent, water or inert gas such as for instance nitrogen are brought at processing temperature and processing pressure and stored in an accumulator. From the accumulator the mixture can be injected under

pressure directly into a mould, by way of various possible injection systems, such as membrane injection point or combinations of injection points.

Additionally the volume of the mould is initially enlarged by moving the halves of the mould apart according to a special pressure profile. In a next stage of the process the halves of the mould are moved towards each other again. Said techniques and the necessary adjustments are well known to the expert however.

The skin obtained will in general preferably be approximately 0.2-5 mm thick at a board thickness of approximately 1 cm. Said skin thickness can be adjusted during the process. The skin is substantially free from visually visible bubbles. As a result a smooth finished surface can be obtained. Possibly it is also possible at manufacturing in a mould to apply a texture on one or both halves of the mould, for instance a wood grain-like texture. In this way a board can be obtained having a wood-like texture.

It could also be possible to provide the walls of the mould used in the manufacturing process with a foil or to provide the board with a separate foil afterwards. By using foil the surface properties of the board can be adjusted as desired. Examples are foils which increase the scratch resistance (for instance polycarbonate foil) or decorative foils.

Because the board has a foam core, it is possible to manufacture board material having a low specific gravity. It is possible to manufacture a wood substituting board having a specific gravity of maximally 700 kg/m^3. If so desired a board can be manufactured having a specific gravity of 600 kg/m^3 at a maximum. For an optimal wood substitute a specific gravity of 700-800 kg/m^3 turned out to be optimal.

Because of its excellent properties the board according to the invention is extremely suitable for building or construction material, preferably for exterior applications.

In figure 1 an example can be seen of a board according to the invention. Here 1 is the substantially solid skin and 2 the foam core. The foam core has a very fine foam structure.

Claims

1. Board provided with a foam core having a substantially solid skin on both sides, in which the foam core and the skin are made of the same synthetic compound which comprises a thermoplastic polymer and cellulose-based filler, the cellulose-based filler being in powder form.

2. Board according to claim 1, **characterized in that** the synthetic compound comprises at least 45% by weight cellulose-based filler.

3. Board according to claim 2, **characterized in that** the synthetic compound comprises at least 60% by weight cellulose-based filler.

4. Board according to any one of the preceding claims, **characterized in that** the thermoplastic polymer is poly olefin or a biologically degradable thermoplastic having a quantity of 40-60% by weight of the synthetic compound.

5. Board according to any one of the preceding claims, **characterized in that** the thermoplastic polymer comprises plastic industrial production waste.

6. Board according to any one of the preceding claims, **characterized in that** the thermoplastic polymer is polypropylene, polyethylene or polystyrene.

7. Board according to any one of the preceding claims, **characterized in**

that the cellulose-based filler comprises sawdust, wood flour, agro-fibre, paper or textile waste.

8. Board according to any one of the preceding claims, **characterized in that** the specific gravity of the board is 700-800 kg/m^3.

9. Board according to any one of the preceding claims, the cellulose-based filler having a particle size of 35-60 mesh.

10. Board provided with a foam core having a substantially solid skin on both sides having a specific gravity of 700-800 kg/m^3, in which the foam core and the skin are made of the same synthetic compound which comprises 40-60% by weight of polypropylene, polyethylene or polystyrene and 45-65% by weight of cellulose-based filler, in which the cellulose-based filler substantially comprises sawdust, wood flour, agro-fibre, paper or textile waste in powder form having a particle size of 35-60 mesh.

11. Process for the manufacturing of a board according to any one of the preceding claims using low pressure injection moulding in a gas-proof mould at a mould pressure of 60 bar at a maximum and in which a gas counter pressure prevails, sufficient to prevent premature expansion of the injection mixture which comprises thermoplastic polymer, cellulose-based filler and blowing agent or water or inert gas, in which after the mould has been partially or entirely filled the injection mixture is allowed to expand, the mould providing counter pressure.

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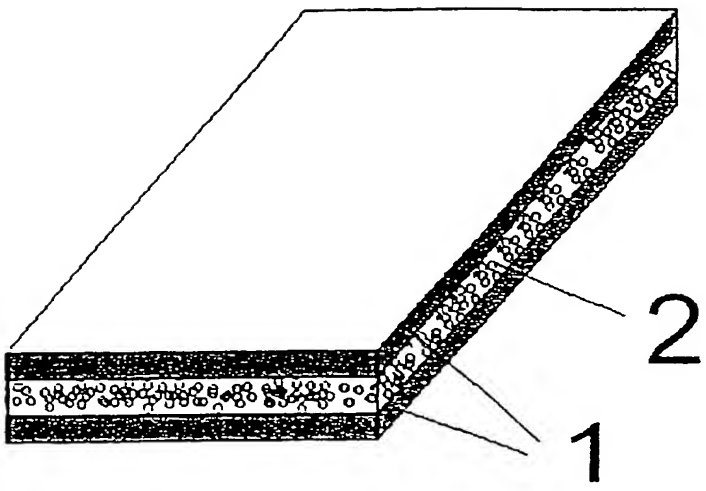

FIG. 1

INTERNATIONAL SEARCH REPORT

Ir. ational Application No
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A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 B29C44/04 B29C44/10

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 B29C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	DATABASE WPI Section Ch, Week 199916 Derwent Publications Ltd., London, GB; Class A14, AN 1999-185055 XP002152040 & JP 11 034148 A (MITSUI PETROCHEM IND CO LTD), 9 February 1999 (1999-02-09) abstract	1-3
X	US 3 773 873 A (SPAAK A ET AL) 20 November 1973 (1973-11-20) claim 1	11
A	GB 1 052 289 A (HAVEG INDUSTRIES INC.) claims	1-10

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
6 November 2000	16/11/2000

Name and mailing address of the ISA	Authorized officer
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International Application No
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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 4 818 604 A (TOCK RICHARD W) 4 April 1989 (1989-04-04) column 3, line 15 - line 26; claims	1-10
A	FR 2 684 966 A (GOMEZ DANIEL ;TECH PAPIER CENTRE (FR)) 18 June 1993 (1993-06-18) claim 21	9

Form PCT/ISA/210 (continuation of second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
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FR 2684966 A	18-06-1993	EP 0546956 A	16-06-1993